Transforming the Electricity Value Chain: A View from Consumer Demand

Cuifen Bai, Fang Yang, and Yibin Zhang

***Abstract*—With the influence of external environment, greater consumer involvement will appear in electricity value activities. To meet the new consumer demand, new value parties will emerge, and the relationship in the traditional electricity value chain may be deconstructed. This paper discusses the possible transformation mode from a consumer demand view. The new demand of consumers is firstly presented, and then the transformation of electricity value chain is discussed. It was found that the new parties and business models will disconnect the previous link in the value chain and probably reconstruct as a value network. A vertical analysis of each party's business model and a horizontal analysis of the net-like relationship among them are performed. Finally, an example of value network illustration is given to describe the value activities in distributed generation.**

***Index Terms*—Value chain, value network, consumer demand, transformation.**

I. Introduction

For a long time, electricity customers have been a passive recipient of electricity. They are informed the energy consumption through the only billing service in one month or less frequent. It is acknowledged that the relationship between electricity providers with consumers is rather lopsided [1]. However, this relationship is being redefined gradually due to greater consumer involvement. The change of consumer may ascribe to the combination of three external environmental factors: energy and climate issues, development of technology, and Internet economy. These three factors influence consumer demand more or less. Firstly, with energy and climate concerns, some consumers take the environmental factor account into product choosing, and they expect the electricity provided is environment-friendly. Secondly, technology advances offer the possibility of smart energy consumption, and the equipment in their life and work is supposed to bring more convenience and economic. Thirdly, the Internet economy further strengthens the role of consumers in companies' business models, which are always consumer-oriented. As a result, they will become more participatory in electricity industry just like the situation in media, mobile manufacture, and so on.

To meet consumers' new energy demand, the electricity industry has to develop new business models to provide the value. Hence, enormous new value providers will emerge, and traditional electricity value chain will be transformed. The relationship among relevant parties in the chain will be complex as a network. Consequently, the electricity industry will transform from a value chain to a value network. This transformation has been researched in other fields [2]-[4], however, not in the electricity industry. Some studies have been done in the electricity value chain transformation, but without definite form [1], [5]. In addition, specific key business models in certain part of the chain have been researched [6]-[9]. All the existing findings have brought new insight into the transformation, and they are considered as a research basis of this paper.

The rest of this paper is organized as follows: Section II gives a brief introduction to relevant theories. Then, consumer demand will be discussed in detail in Section III. In Section IV, the transformation of electricity value chain is analyzed. Firstly, the main components and the related business model of traditional electricity value chain are analyzed. Afterwards, in order to meet consumer's new demand, the new parties and business models emerging are discussed. Then, value network analysis is applied to illustrate the relationship between the parties, and a detailed example is given to describe a value activity. Section V is the conclusion part.

II. An Brief Introduction to Relevant Theory

A. From Value Chain to Value Network

The value chain model was proposed by Porter in 1985 [10]. A major contribution of Porter's value chain is that it decomposes the value-added process of a company into a series of value activities and provides a method to describe the value activities. In General, it is applied to analyze the competitive advantage of an individual company. Further, it can be extended to use in industrial and global level. In this context, the value chains of all companies involved interconnect as a value system [11]. The process from supply to consumption all can be described in the value system. The value chain model has been considered as a powerful competitive advantage analysis tool, and widely used and developed in many fields for the last 30 years.

However, under the situation of economic globalization, it is also confronted with a number of challenges. With the pressure of competition increasing, companies tend to develop their relationships further to co-operation and co-ordination, and the competition is increasingly taking place between networks. As a result, it is complicated for the value chain analysis method to deal with this situation. Additionally, the value chain model mainly focuses on the long run profit of a company, without consideration of the

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customer satisfaction, which plays a more and more important role in the development strategic nowadays.

With the intense competition and an increase of customer demand, the value chain mode tends to evolve into a value network model. Although there has not been a clear definition of the concept of value network, some points differing from the value chain are supposed to be noted. Firstly, the value network lays emphasis on the collaboration relationship rather than an individual company. All companies, as nodes in the network, create value through cooperation and win-win business philosophy. Secondly, consumers are considered as the starting point and focus in the value network model. The two point discussed above can be illustrated in Fig. 1. Additionally, intangible assets will play a more and more crucial role in the future, and value network analysis offers a way to model, analyze, evaluate, and improve the capability of a business to convert intangible assets into other forms of negotiable value [12].

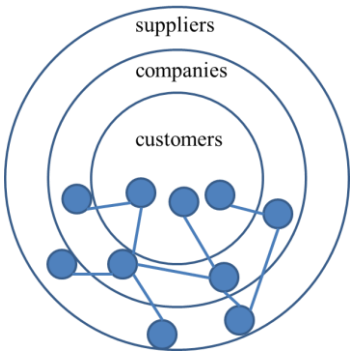

Fig. 1. The value network [3], [13].

B. Business Model

The definition of business model has been given by different literatures from different perspectives. Lots of authors have reviewed on the present business models [14], [15], but none of the definitions or components have appears to be accepted fully. Detailed content can be found in these papers, and they will not be covered here. The business model analysis is used to illustrate the value activities in the value chain or value network in this paper. For this purpose, the main components, value proposition, value creation, value delivery and value capture, are comprised in the business model.

III. Analysis of Consumer Demand

As the discussion at the introduction part, the influence of climate change concerns, technology advances and Internet economy development lead to a greater consumer involvement. From the view of consumer demand, this change can be expressed as more spiritual needs are being pursued according to Maslow's hierarchy of needs [16]. Except for the basic need of availability, consumers expect to obtain other forms of value from electricity.

Climate change and energy issues have gained more attention in recent years. Thus, when consumers choosing product, environmental considerations may be more involved. On the one hand, governments around the world reach an agreement on energy conservation and emission reduction, and lots of energy policies and legislation are established. Utilities and commercial consumers are compulsory to concern the cleanness of energy. On the other hand, the strengthening of people's environmental awareness results in the willing of common consumers to make a contribution to environmental protection. Hence, they want the energy provided to be much cleaner. Furthermore, some of them may desire an opportunity to participate in and make a contribution to climate change and energy issues.

Technology advances have offered a possibility of the realization of consumer demand. For example, smart home provides a way to take care of household duties remotely, so that consumers can manage their life more freely and conveniently. Smart metering updates electricity consumption information in real time which is essential for consumers to manage electricity consumption and through its bi-directional communication channel with the energy supplier, consumers can sell back surplus power they generate. Distributed generation technologies can turn consumers into prosumers, and more cost-effective and environment-friendly energy solutions may be created. It can be seen that advanced technologies can offer consumers with a means of involving in the electricity industry, and some consumers are keen to utilizing these technologies to better manage their life and work.

With Internet economy development, consumers are being increasingly committed to involvement in tertiary industry. There is a possible trend that the energy industry may also follow this trend, and consumers desire to have more right to know, to participate and to choose in the electricity industry. It should be noted that although climate changes concerns and new technologies emergence have been put forward before, with a massive shift toward more active and independent consumer behavior in the environment of Internet economy, the combination of these factors is compelling consumers' role transformation in the value chain.

The theoretical analysis above indicates that consumer demand is being gradually changing with external environment. Additionally, actual investigation has also confirmed this conclusion. IBM has done surveys of 1,900 energy consumers and nearly 100 industry executives across the globe1. It is found that 70 percent of consumers stated that environmental considerations were already an important factor in choosing products other than energy, and these concerns also influenced the energy products they bought. 84 percent of those who could not change providers or were not aware of their ability to choose wanted the option, obviously indicating that consumers desired a choice.

To sum up, with the combination influence of climate change concerns, important technologies advances and Internet economy development, consumers' energy demand are making a transition from the traditional focus on availability to cleanness, contribution, optionality, participation, in other words, more spiritual needs are desired. They expect electricity industry can provide more types of value activities to meet their desire. For example, they may want to have the ability to choose different types of electricity packages from a wide variety of suppliers; they can actively and conveniently manage energy consumption, or generate and sell electricity as a prosumer, and so on.

IV. Transforming the Electricity Value Chain

The analysis of the change of consumer demand shows that new value should be generated and provided to consumers to meet their demand. The traditional electricity value chain is firstly studied in this section. Afterwards, the appearance of new value demand and its influence to the value chain are discussed.

A. Traditional Electricity Value Chain

The traditional electricity value chain is shown in Fig. 2. The main value activities, electricity generation, transmission, distribution, retail and consumption are briefly discussed in the following.

The role of generation node in the value chain is to convert primary energy resources into electricity. So far, large scale centralized power plants with fossil fuels have been the primary method of generation. Additionally, the power plants are mostly manipulated by a few of large utilities.

Fig. 2. Traditional electricity value chain.

Due to the influence of geographic environment, the primary energy resources usually are not close to residential areas. That is to say, the electricity is supposed to be transported a long distance from the generation area to the consumption centers. This value is provided by the transmission part. It transports electricity at high voltage over long distances through transmission grid. Considering the importance role of balancing the electricity supply and demand this part plays, and numerous grid stability and security issues involved, the transmission grid is commonly monopolized by a certain utility.

When electricity is transported at high voltage to an area near to the consumption, it is delivered to the end consumers at low voltage level through distribution grid. The distribution part is essential because it is the portal that directly connects electricity with the end consumer.

Retail means to buy electricity from producers and sells it to consumers with different pricing packages. The billing is offered to consumers through metering.

In the consumption part, electricity energy is converted into kinetic energy, heat, cold, light, or other energy forms by consumers' devices and appliances, providing the basic energy needed in human production and life.

The discussion above indicates that each part in the traditional electricity value chain is linear linked. Energy and information flow in one way in this chain, and the only value forms provided to consumers are electricity and billing. Consumers are treated as passive receiver of energy. The detailed value activities involved in the business model in the value chain is shown in Table I. The type of value proposition is considered to include material product, material service, information product and information service. It indicates that the traditional value chain bring consumers material product (Electricity is considered as a special material product) and information product which are the low-end of the common value chain.

B. Value Chain Deconstructed and New Value Emerges

As Section III mentioned, consumers will take a more active part in the electricity value chain. Their new energy demand will directly influence the value creation process of every stakeholder in the value chain, and also new type of value providers will emerge in certain position of the chain. In other words, from the consumer demand view, the electricity value chain is supposed to be deconstructed and provide more different forms of value. The following paragraphs take a look at the opportunities associated with consumer demand, as shown in Fig. 3 and Table II.

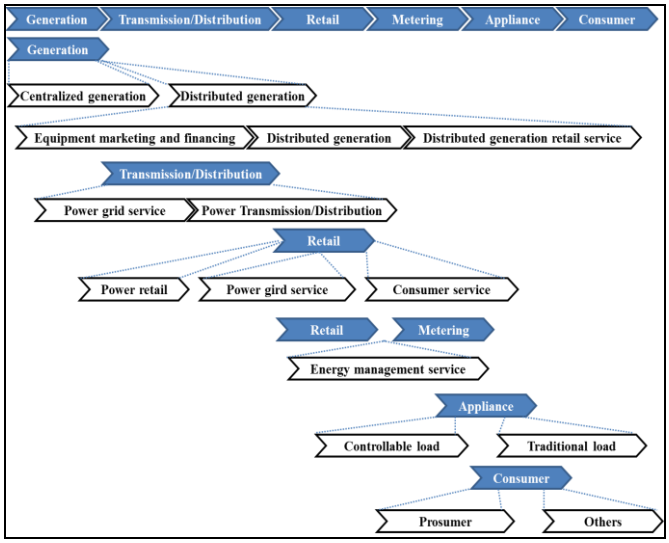

Fig. 3. The deconstruction of traditional electricity value chain.

TABLE I: Business Model Analysis in the Traditional Electricity Value Chain

Value activities	Value Proposition			Value Creation	Value Delivery		Value Capture
	Object	Type	Content		Medium	Mode	
Generation	Retail, Transmission /Distribution	Material Product	Electricity from large scale power plant with fossil fuels	Convert the primary energy sources into electricity	Power grid	B2B	Electricity sale
Transmission / Distribution	Consumer	Material Service	Electricity Transmission/ Distribution	Transport/ distribute electricity	Power grid	B2B B2C	Transmission and distribution price
Retail	Consumer	Material Product	Electricity sale	Sale the electricity to consumers	Power grid	B2B B2C	Electricity sale
		Information Product	Billing	Billing generation	The entity business hall; mobile, Internet	B2C	Billing received

Appliance	Consumer	Material Product	Appliance	Appliance production and provide	Logistics transportation	B2B B2C	Appliance sale
Consumer	-	-	-	-	-		-
Electricity value chain	Consumer	Material Product	Electricity	Generation, transmission, distribution and retail	Power grid	B2B B2C	Electricity sale
		Information Product	Billing	Billing generation	Paper file or electronic file	B2C	Billing received

TABLE II: PARTIAL VALUE ACTIVITIES IN THE NEW ELECTRICITY VALUE CHAIN

Value activities	Value Proposition			Value Creation	Value Delivery		Value Capture
	Object	Type	Content		Medium	Mode	
Generation	Retail, Transmission /Distribution	Material Product	Electricity from large scale power plant Electricity from more Environment-friendly production	Convert the primary energy sources into electricity	Power grid	B2B	Electricity sale
Distributed generation	Consumer	Material product	Distributed generation equipment	Equipment production	Logistics transportation	B2C, C2B	Equipment sale
		Material service	Financing, purchase, installment, maintenance, connection	Service offering	Internet, power grid	B2C, C2B	Service offered
		Information service	Consult	Service offering	Internet, mobile	B2C	Service offered
Transmission/distribution	Consumer	Product Service	Electricity Transmission/ distribution	Transport/distribute electricity	Power grid	B2B B2C	Transmission and distribution price
	Power gird	Information Service	Service for power grid operation	Service offering	Internet, mobile	B2B C2B	Service offered
Retail	Consumer	Material Product	Differentiated electricity sale	Sale electricity to consumers	Power grid	B2B, B2C, C2B	Electricity sale
		Product Service	Virtual power plant	Distributed energy aggregation	Power grid	B2B, B2C	Electricity sale
		Information Product	Billing, other information related to living	Information generation	Internet	B2C, C2B	Information offered
	Power grid	Product Service	Demand side response	Load shifting	Power grid	B2B	Service offered
Third-party	Consumer	Product Service	Energy management	Energy saving	Equipment, Internet	B2B, B2C, C2B	Service offered
Appliance	Consumer	Material Product	Appliance	Appliance production	Logistics transportation	B2C, C2B	Appliance sale
		Material Service	Installment, maintenance	Service offering	Equipment	B2C, C2B	Service offered
Consumer	Power gird	Material Product	Surplus electricity	Distributed generation	Power grid	C2B	Electricity sale
New Electricity value chain	Consumer	Material Product	Differentiated Electricity	Generation, transmission, distribution and retail	Power grid	B2B, B2C	Electricity sale
		Material Product	Equipment, appliance	Equipment, appliance generation	Logistics transportation	B2C, C2B	Equipment, appliance sale
		Material Service	Virtual power plant *et al.*	Service offering	Internet, power grid, equipment	B2C, C2B	Service offered
		Information Product	Billing, other information related to living	Information produced	Internet	B2B, B2C	Information offered
		Information service	Consult	Service offering	Internet	B2C	Service offered

In the generation part, due to consumers' cleanness demand, it will split into two major modes, centralized and distributed generation. A new value proposition of centralized generation is proposed, which is to offer electricity from more environment-friendly production. In addition, distributed generation primarily comes from renewable energy, and various relevant service providers will emerge.

For transmission/distribution, a special service will be provided for power grid operation in order to ensure its reliability and security with many new elements added and to strengthen the interaction with consumers.

Retailors will play an essential role in meeting consumers' demand of cleanness, contribution, optionality, participation. For example, differentiated electricity service will offer consumers more optionality; virtual power plant service will bring consumers an opportunity to participate in the electricity sale market and service market. Besides, retailors can serve power grid in form of demand side response and others.

A third-party mainly with energy management will emerge to meet consumers' demand on participation in energy management in work and life.

With technology advances and business model development, some load becomes controllable to be managed by consumers in the energy management or participate in the service market to interact with power grid.

With the decentralized generation development, some of traditional consumers will become prosumers, and they also can build their own business model by selling back the electricity, rather than a traditional passive receiver.

Although only partial value activities of business models are discussed, it indicates that the reconstructed value chain newly adds various types of product and service to better meet consumer demand. A vertical analysis on the business models of each node in the value chain is given in Table II. However, the horizontal analysis on the relationship among the relevant parties will become too complex to analyze through value chain. Hence, value network analysis will be discussed in the next section.

C. Value Network Analysis

Value is co-created by a combination of all players in the network, and their relationship is possibly illustrated in Fig. 4. It should be noted there may be various possibilities in the future, and not all the player are considered into the figure; the figure just give a possible example.

For this example, first take a glance of the degree of closeness of their relationship. Consumer is located in the center, and all value activities are consumer-oriented. Then, distributed generation and appliance are put in the second circle since they have the closest relationship with consumers' daily life. In the third circle, there are a consumer service network platform and the providers aggregate on it. Platform is very common under the situation of Internet economy, which provides a channel for providers and buyers to interact. Power system is in the fourth circle to make a deal with consumers through the platform. The material or information product providers to the platform are put into the outmost circle. Furthermore, considering the flows between them, two things are noteworthy. Firstly, all the information flows will be bidirectional. Secondly, the value flow and cash flow are mostly inverted, which constitute a close loop of value activity.

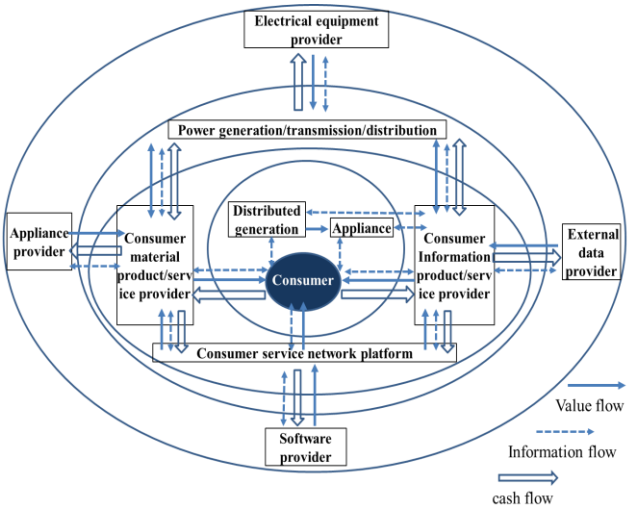

Fig. 4. An illustration of value network.

This value network analysis indicates the degree of closeness of relationship between the parties involved and also the value flow between them. To describe more clearly, a more detailed value network for a value activity can be illustrated, such as the example shown in Fig. 5. It is an elaborated illustration to a value activity related to the distribution generation. In the figure, the material value is expressed as a solid line, and the immaterial value is noted as the dotted line which took up a large proportion.

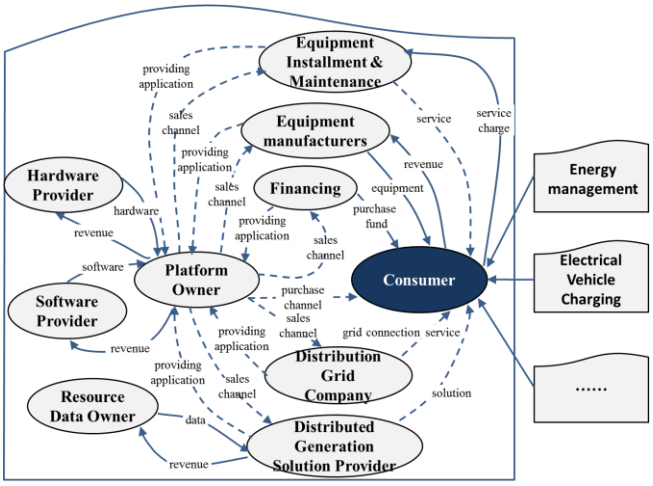

Fig. 5. An example of value network analysis of distributed generation.

V. Conclusion

The trend of transforming from value chain to value network has been researched in many fields. This study makes an attempt to analyze the transformation in the context of the electricity industry from a consumer demand view. The consumers expect greater involvement in the traditional electricity value chain. To satisfy them, new service providers and business models will emerge, which will disconnect the previous link in the value chain and probably reconstruct as a value network. The collaboration of parties in the value network can offer consumers all types of value they demand.

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